Space Weather Technical Forecast

Issued on Saturday, 04 November 2023 at 01:06 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: G1/G2 Minor/Moderate geomagnetic storms expected on the 5th Nov due to CME arrival.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low with only C-class flare activity in the past 24 hours. There are five numbered and two unnumbered sunspots on the visible disc. AR3474 the large spot in the southwestern quadrant, saw some reduction in its trailing region but still displays some magnetic complexity. AR3477 in the southeast also has only a small trailing region, but signs of increased magnetic complexity visible. AR3480 (now Dac/Beta-Gamma) near the southeast limb also appears to be magnetically complex, though due to foreshortening the current analysis is low confidence and may see further changes. All other regions are small and simple with the recent AR3473 and AR3478 regions fading to pores.

A large filament eruption was detected around 03/0430 UTC from the northwest quadrant. Modelling suggest an Earth directed component with an arrival sometime later on the 05 Nov.

Solar Wind / Geomagnetic Activity: Solar wind speeds observed at L1 by ACE are at background levels, slowly declining from 370 km/s towards 340 km/s. Density has persisted at below average values. The total magnetic field strength, Bt, has been persistently weak, with the north-south component, Bz, also varying weakly. Phi angle was predominantly positive (away from the Sun). Geomagnetic activity was Quiet (Kp 0-1) throughout.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at background levels, though slightly above baseline for a time, likely following the filament lift off from the northeast quadrant. GOES16 high energy (greater than 2MeV) electron flux was at High levels from 03/1015 UTC onward, with a peak of 2850 pfu at 03/1705 UTC. The associated 24-hour fluence has been above the Active (1e8 integrated pfu) threshold throughout. The observation for integrated pfu at 04/0000 was 1.3e8.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate solar activity is expected, with chance of isolated M-class flares, these perhaps most likely from AR3477 or the recently numbered AR3480.

Solar Wind / Geomagnetic Activity: Two CME's feature in the forecast, one from the 2 Nov which may arrive late 4 or early 5 Nov, and another from 03/0430 UTC which is expected to arrive later on the 05 Nov.

Solar wind speeds are slow currently. The next enhancements expected from CME influence during day 2 (05 Nov), followed by coronal hole CH67/- which may enhance solar wind speeds to strong, around 600-700 km/s, from later on day 3 or more likely day 4 (6-7 Nov).

Quiet geomagnetic activity expected initially. Unsettled to Active conditions and a slight chance

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of G1/Minor Storms possible during the latter part of day 1 (04 Nov) or more likely early day 2 (05 Nov). Later day 2 (05 Nov) G1/G2 Minor/Moderate storm intervals are expected with a chance of G3/Strong storms due to the arrival of the large filament eruption associated CME from 03 Nov. Days 3 and 4 (6-7 Nov) will likely see geomagnetic activity remain Unsettled to Active due to the expected arrival of the HSS from CH67/-.

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is expected to persist at background levels.

High energy electron flux (greater than 2MeV) is expected to continue to vary between Moderate and High levels initially. A return to background or Moderate levels likely into days 3 and 4 (6-7 Nov). Electron fluence currently exceeding the Active (greater than 1e8 integrated pfu) threshold and is expected to remain above this level day 1 (4 Nov), and likely initially day 2 (5 Nov) with a declining trend into day 3 onwards.

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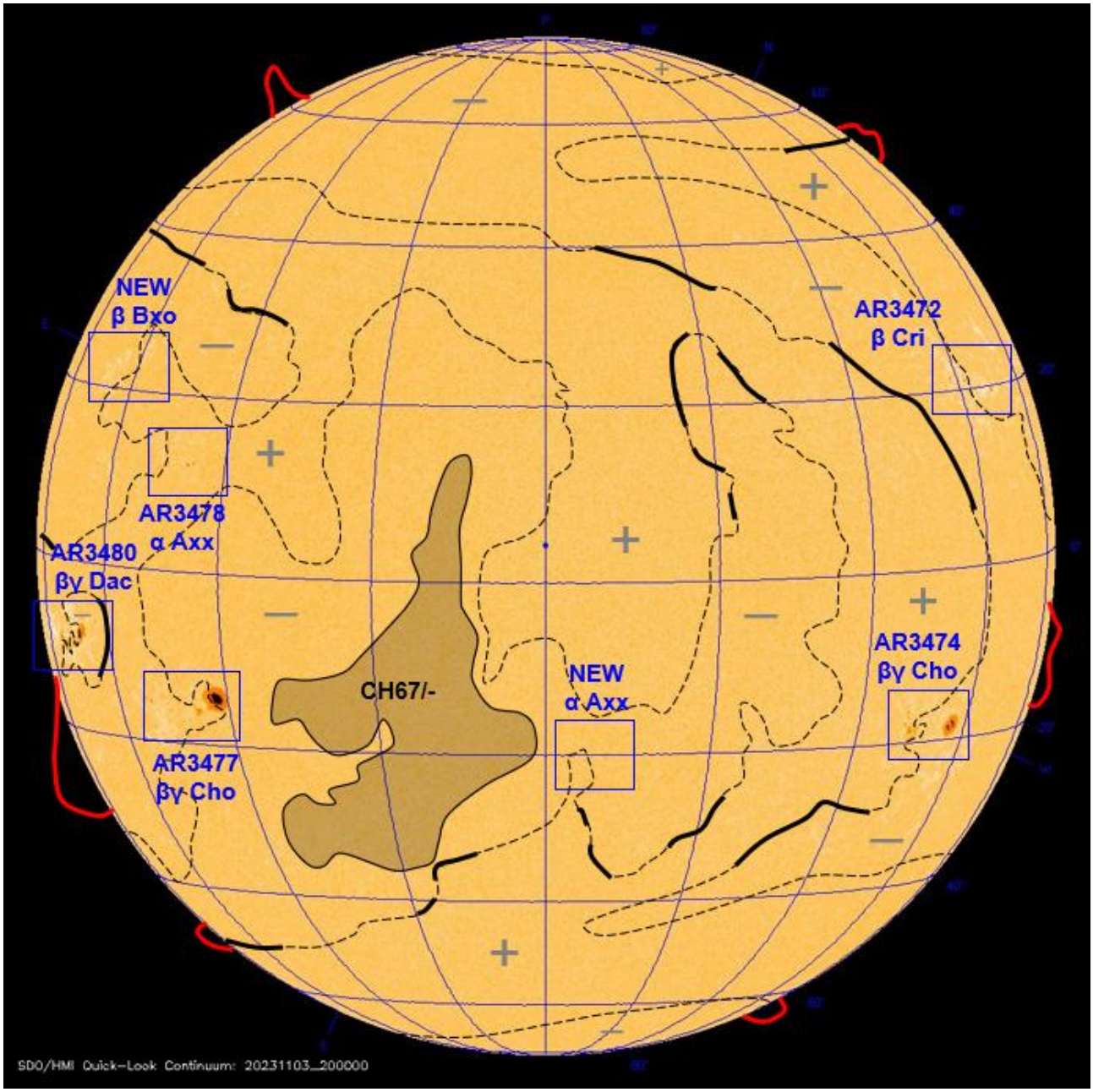
Figure 1. Solar Analysis Valid 03/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are two potentially Earth directed CME that currently feature in the forecast. The first associated with a filament eruption on the 2 Nov from the northeast disk, this may give Earth a glancing blow early on day 2 (05 Nov). A likely more significant CME was associated with a large filament eruption observed in the northwest of the disk on 03/0430 UTC, this has been modelled to see a potential Earth arrival during the second half of day 2 (5 Nov).

Solar wind speeds are currently slow background and expected to remain so during day 1 (4 Nov) and into day 2 (5 Nov) ahead of expected CME influence. The next recurrent enhancement expected to be the large coronal hole CH67/-, currently just east of the meridian, likely to provide an enhancement perhaps late on day 3 (6 Nov), or more likely into day 4 (07 Nov). This coronal hole have some significant differences compared to the previous rotation, but both persistence and ENLIL modelling suggest solar wind speeds of 600-700 km/s possible. The onset of this feature could well be masked by ongoing CME influence.

Quiet geomagnetic activity expected initially. Unsettled to Active conditions and a slight chance of G1/Minor Storms possible during the latter part of day 1 (04 Nov) or more likely early day 2 (05 Nov). Later day 2 (05 Nov) G1/G2 Minor/Moderate storm intervals are expected with a chance of G3/Strong storms due to the arrival of the large filament eruption associated CME from 03 Nov. Days 3 and 4 (6-7 Nov) will likely see geomagnetic activity remain Unsettled to Active due to the expected arrival of the HSS from CH67/-.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	80	30	20
Strong	G3	No	1	30	10	1
Severe	G4	No	1	5	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
02/1804	Partial	Filament Eruption	NE	648 km/s	05/0900 UTC	Glancing blow
03/1137	Partial	Filament Eruption	NW	730 km/s	05/1800 UTC	Nil

Figure 2: Latest MOSWOC ENLIL Ensemble output showing expected CME arival on the 5th followed by HSS influence.

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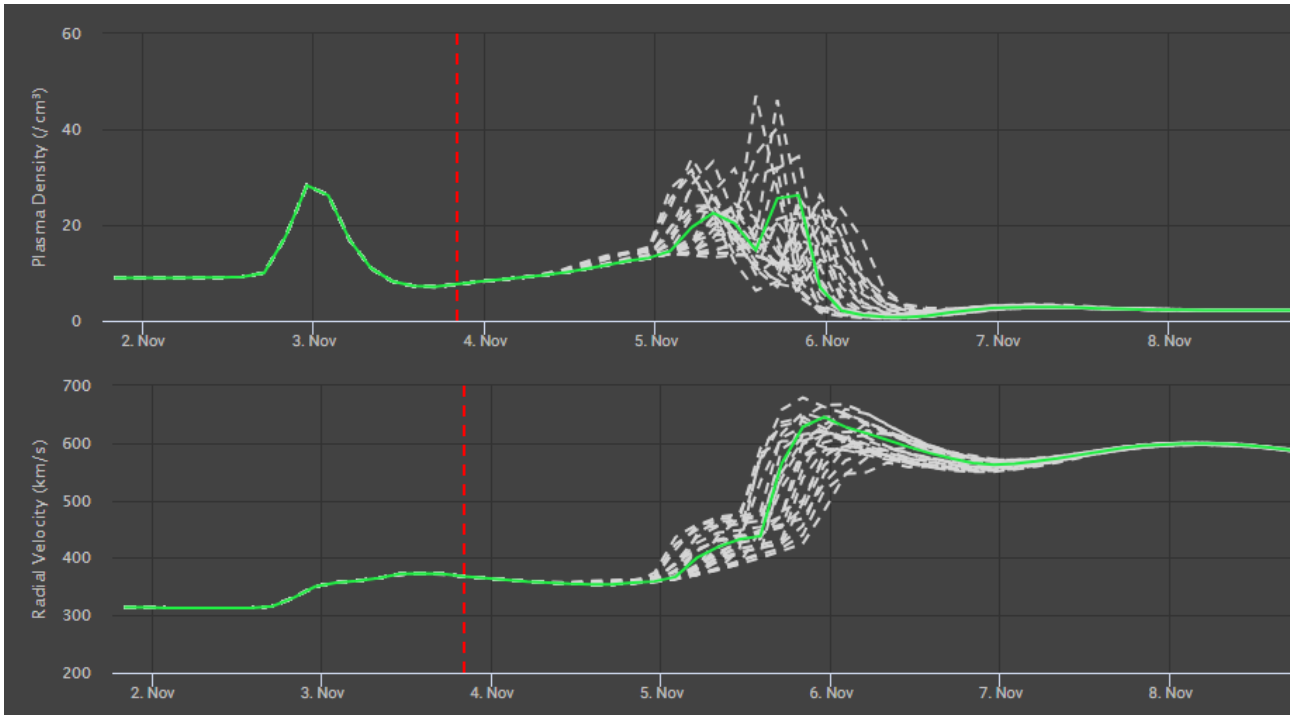

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Met Office Space Weather Technical Forecast

Radio Blackouts - X-Ray Flares:
Low to Moderate solar activity is expected to continue in the absence of further developments, with no significant returning regions expected to round the limb during the period. A chance of isolated M-class flares maintained throughout, these perhaps most likely from AR3477 or the recently numbered AR3480.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	35	35	35	35
Very Active	R3 to R5 X Class	No	5	5	5	5

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Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10MeV) proton flux observed by GOES16 is expected to persist at background levels, although there remains a very slight chance of proton storms given any significant flare activity.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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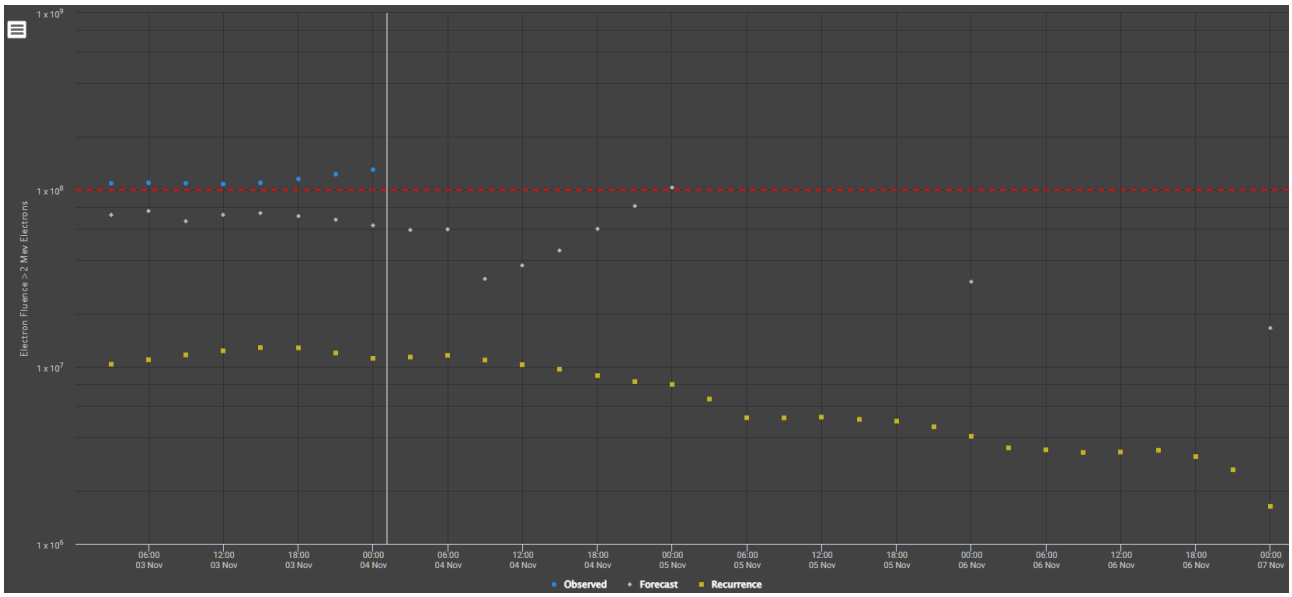
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) is expected to continue to vary between Moderate and High levels initially, with a continuation in diurnal maxima into High levels probable during day 1 (4 Nov) and perhaps initially day 2 (5 Nov), as the enhancement of the previous HSS from CH66 continues. A return to background or Moderate levels likely into days 3 and 4 (6-7 Nov) however, due to expected geomagnetic activity and subsequent electron redistribution.

Electron fluence currently exceeding the Active (greater than 1e8 integrated pfu) threshold and is expected to remain above this level day 1 (4 Nov), and likely initially day 2 (5 Nov) with a declining trend into day 3 onwards. The MOSWOC REFM model is therefore considered to be offering good guidance regarding the general trend of the fluence, although the model is currently underestimating the fluence and has us below the 1e8 integrated pfu threshold.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	Yes	100	90	20	5
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 3: Latest MOSWOC REFM model output, general trend viewed as good guidance.



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